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13. ABSTRACT (Maximum 200 words) This DURIP equipment supplement provided the apparatus needed for development and execution of a unique method in femtosecond pulse shaping. In particular, the method allows a single laser beam with a single femtosecond pulse to be transformed into many spatially separate beams, each one with a specified sequence of femtosecond pulses.	
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This DURIP equipment supplement provided the apparatus needed for development and execution of a unique method in femtosecond pulse shaping. In particular, the method allows a single laser beam with a single femtosecond pulse to be transformed into a many spatially separate beams, each one with a specified sequence of femtosecond pulses. In this “spatiotemporal” pulse shaping, a complex optical field can be generated with many ultrashort pulses that arrive at specified locations on a sample at specified times. From a fundamental point of view, this enables coherent optical control over material responses that move through a sample at light-like speeds, using some pulses to initiate the response at one sample location and other pulses, arriving at other sample locations at specified times, to manipulate the rapidly moving response. The method has been applied successfully to the manipulation of coherent polariton responses. These are very short, very fast electromagnetic/polar lattice vibrational responses that induce large fields and crystalline displacements wherever they go in the sample.

From an applications point of view, the method permits highly multiplexed generation of ultrahigh (THz) bandwidth optical signals. These can be made to arrive at specified addresses on a device at specified times. In the application demonstrated by us, the polariton responses can be viewed as THz-bandwidth signals. These signals are controlled and manipulated as they move at light-like speeds among different addresses on a device. Thus we have demonstrated

extraordinarily high-bandwidth optical signal processing. Applications in high-bandwidth photonics switching, using semiconductor samples, are currently being pursued.

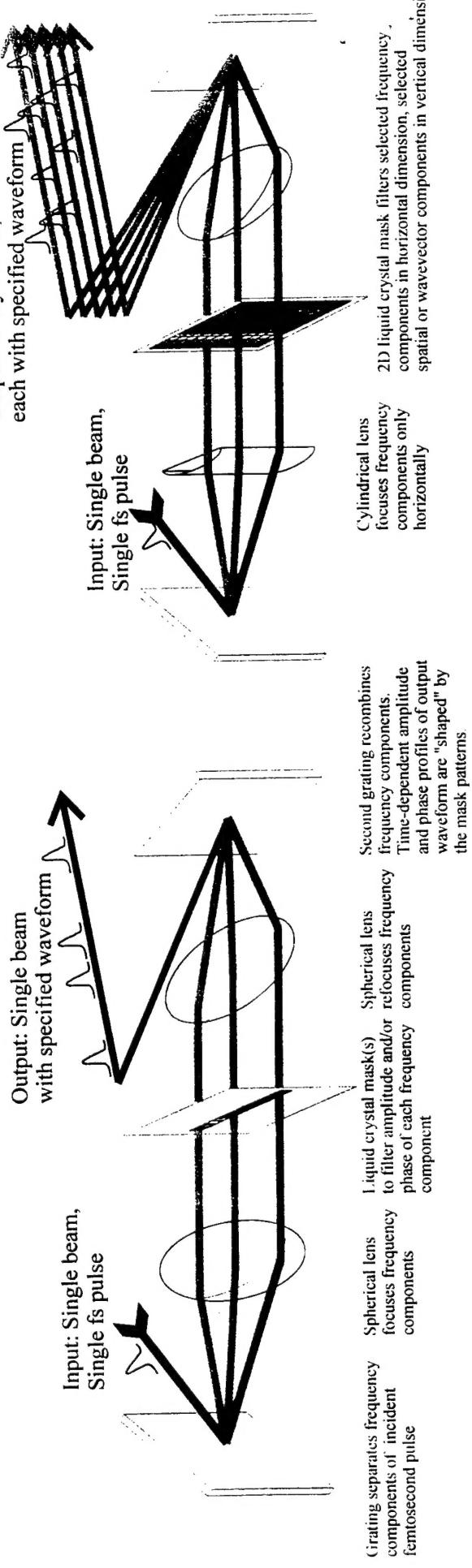
The attached figure 1 shows the automated femtosecond pulse shaping results. The pulse shaping principles are illustrated in figures 1a and 1b, the automated pulse shaper is illustrated schematically in figure 1c, and a spatially and temporally shaped output consisting of three separated beams, each with several pulses, is shown in figure 1d.

The attached figure 4 (both figures are taken from a recent ARO proposal) illustrates the use of the spatiotemporal pulse shaper for spatiotemporal coherent control over polaritonic signals moving at light-like speeds. Figure 4a shows the experimental arrangement. Figure 4b shows the output of the spatiotemporal pulse shaper, consisting mainly of 14 pulses, each separated spatially and temporally such that one after the other generates and repeatedly amplifies the propagating signal. This is analogous to a traveling wave amplifier for GHz electronics, but at THz frequencies and bandwidths. It is a first demonstration of what will be a broad range of ultrahigh-bandwidth electrooptical signal processing capabilities.

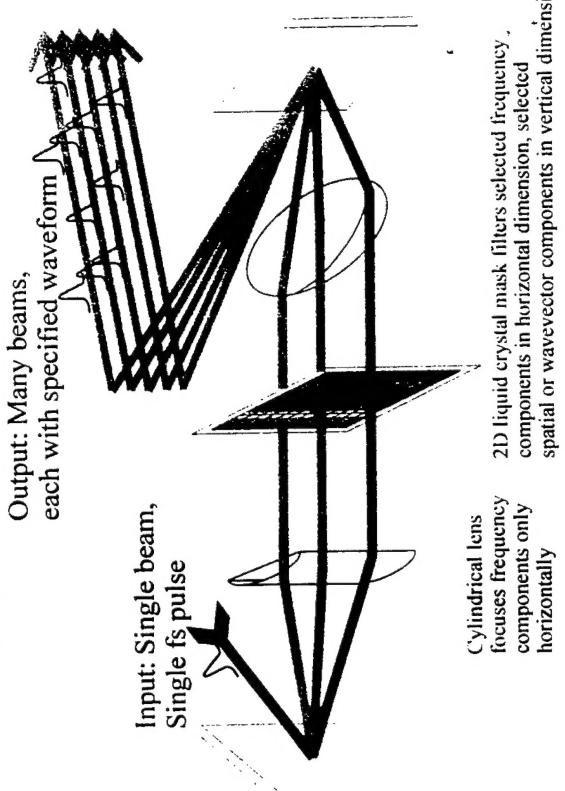
The results of this project have been submitted for publication, and additional submissions will be forthcoming.

Figure 1. Spatiotemporal femtosecond pulse shaping

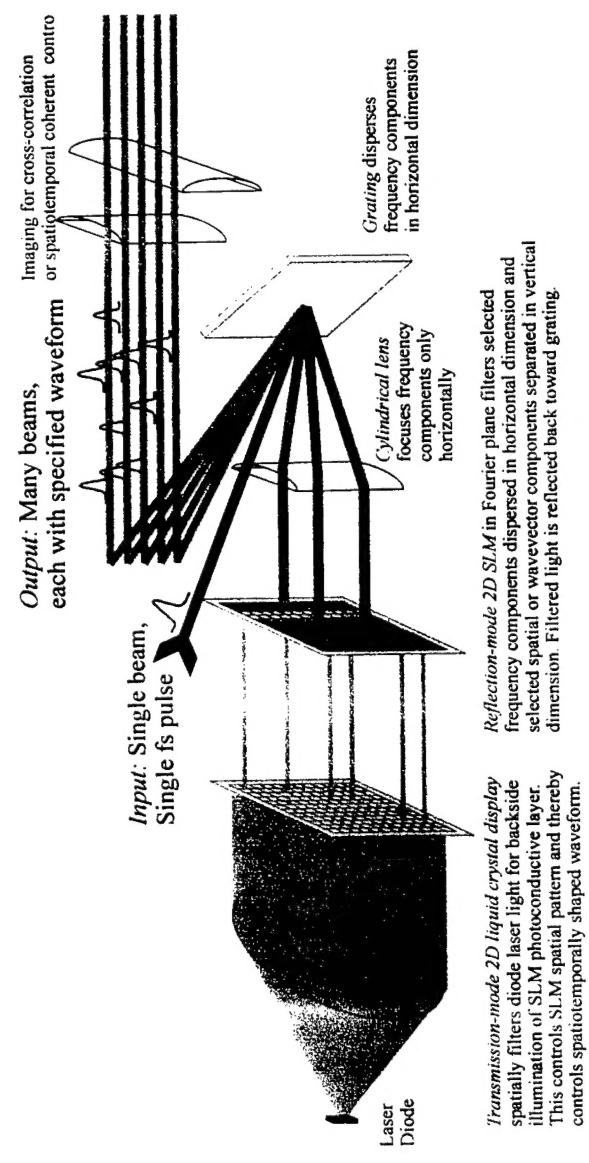
(a) Temporal-only Pulse Shaper



(b) Spatiotemporal Pulse Shaper



(c) Automated Spatiotemporal Pulse Shaper



(d) Spatiotemporally Shaped Output

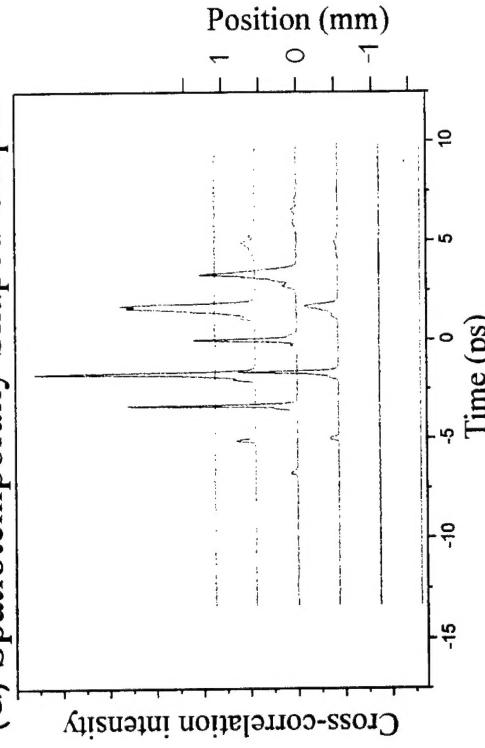


Figure 4. Spatiotemporal coherent control (automated)

